THURSDAY, MAY 29, 1902.

THE SUPPLEMENT TO THE ENCYCLOPÆDIA BRITANNICA.

Encyclopaedia Britannica. Vol. xxv. Pp. xiii + 786. (Aachen to Australia.) Edited by Sir Donald Mackenzie Wallace, K.C.I.E., K.C.V.O., A. T. Hadley, President of Yale University, and Hugh Chisholm, B.A. (London and Edinburgh: A. and C. Black; London: The *Times* Office, 1902.)

THE critical student familiar with the ninth edition of the "Encyclopædia Britannica" would have no difficulty in detecting a change of intellectual attitude upon examining the volume before us. When the articles were prepared for the ninth edition, in the seventies and eighties of last century, scholastic traditions had a greater influence in determining the point of view than they have to-day. The result was that early periods of history and early developments of the arts and sciences received far more attention than modern views and methods. The significance of the present was disregarded in the contemplation of the past, while the promise of the future was mostly left out of consideration altogether. This retrospective spirit pervaded very many of the articles, and may be said to represent the characteristic style of a generation educated upon literary ideals. Knowledge was regarded as a structure to be observed in various aspects—as material for philosophy—rather than as something to which continual additions should be made, which alter the character of the whole edifice.

Many changes have occurred during the quarter of a century which has elapsed since a large part of the ninth edition was written. The centre of gravity of the intellectual world has for some years been changing its position, and is now much closer to science than it was, though the humanities have not ceased to exert their influence against the movement. There is still a strong disposition to resent any attempt to disturb a balance which has been preserved for so long. Science is considered as a useful servant, which adds to the comforts of life by the practical applications to which it leads, but the pursuit of natural knowledge is not usually considered so dignified and inspiring, or worthy of honour, as art, or literature, or music. In fact, science in England is a drudge to be tolerated, but her pretensions to a position upon the councils of State, or to rank among essential subjects in education, are scarcely countenanced. A man ignorant of the elements of science, and contemptuous of the value of the study of nature in the formation of character, may, even in these days, arrogate to himself the right to define its limits; and he may depend upon the support of all who wish to preserve the old studies from the influence of the progressive school. It is the familiar story of conflict between old and new knowledge, or, to use another simile, between ancient and modern faiths. The priests of the traditional shrine look with disdain upon the altar erected to science, and warn orthodox worshippers against its influence. But mental developments create new attitudes of mind, and unless the guardians of ancient views adapt themselves to new circumstances, they are in opposition to the whole spirit of progress.

In the new volume of our national encyclopædia, it is satisfactory to observe the change that has occurred to bring the work in touch with current scientific results and opinions. The articles upon scientific subjects are numerous, as well as being substantial statements upon the state of various branches of natural knowledge—from the points of view both of the student and the practical man. Among the subjects dealt with are every important country or region with names between Aachen and Australia; in addition to accumulators, acetylene, achromatic objectives, acid and alkali manufacture, acoustics, Adams, adulteration, aëronautics, æther, agriculture, agricultural machinery, air-gun, Airy, algæ, algebra, algebraic forms, alloys, aluminium, amphibia, amphioxus, anatomy, angiosperms, antelope, anthozoa, anthropology, anthropometry, appendicitis, aquarium, aqueduct, arachnida, argon, armour, assaying, astronomy and atmospheric electricity.

It will easily be understood that adequate notice of these contributions could not be given in a review; so all we can do is to describe a few of the subjects surveyed.

The ten pages devoted to "Accumulators" contain a clear account of the principles and structure of several typical cells. In an excellent section on the setting up, forming and discharge of cells (p. 29), the word "hygrometer" is an obvious mistake for "hydrometer." Failures, their remedy and avoidance, are illustrated from a number of charge and discharge curves from actual experiments. The chemical reactions receive due attention, and, finally, the uses of cells in central station work and trams are shortly discussed. It is, however, surprising to find no mention of Salomon's work in the references to the literature of the subject.

Under "Acetylene," a concise account of the stability of the gas under various conditions is followed by a short description of the "ingot" and "run" methods of making carbide, a good *résumé* on the purification of the gas, and a few words upon generators and burners, which might with advantage have been extended.

A short article on "Achromatic Lenses" mentions the recent success of Jena glass and Abbe's experiments.

Under "Acid and Alkali Manufacture," in addition to the well-worn description of sulphuric acid plant, we find an interesting account of the "contact" method for producing SO_3, followed by some details upon the condensation of hydrochloric acid from the salt cake process, and subsequently some valuable judicial statements upon the position of the Leblanc process and the inroads of electrolytic methods.

Under the heading "Acoustics," we have an investigation of the change in form of sound waves of finite amplitude, effects of temperature and wind, short descriptions of König's tuning fork, McLeod and Clark's stroboscopic methods and Lord Rayleigh's phonic wheel, the electrically maintained tuning fork, sensitive flames and jets. Brief investigations are given of Fourier's theorem and the methods of determining the specific heat ratio of air from the velocity of sound. The section on combination tones is of special interest in connection with recent researches.

The article on "Aëronautics" is of especial interest in connection with modern experiments, both on the propulsion of balloons and on flight proper. It is illustrated by excellent photographs of both Zeppelin's and Santos Dumont's machines, and contains valuable statistical information in the form of tables, which will enable the reader to compare at a glance the means employed and the results achieved in attempts to navigate the air both by the *plus léger* and the *plus lourd* methods. A remarkable result shown by the tables is the very great advance made in increasing the weight sustained per horse-power in the gliding experiments under gravity made by Lilienthal, Pilcher and Chanute, though the writer of the article expresses the opinion that the substitution of an artificial motor would reduce these results by one-half. Another table gives the resistance of surfaces at different incidences, calculated for planes by Duchemin's formula and for curved wings from Lilienthal's investigations; and among other features we notice illustrated accounts of Chanute's gliding machines, Langley's and Hargreaves' aërodromes, and Ader's "Avion." With such information the reader will have little difficulty in forming a correct estimate of the present state of aërial navigation.

It is difficult to summarise briefly the contents of the important article on "Æther." The necessity for assuming the existence of an æther, the differences between æther and matter, the question as to whether the æther is in motion and the dynamical theories of the æther form the chief themes of the article. At the present time "æther" has become an every-day word, but few who use it have much idea of what it means. The present article is clear and authoritative, and if it does not answer the unanswerable question, "What is æther?" it does much to place this question on a sound and scientific basis.

The article "Agriculture" deals, in two separate chapters, with the changes that the past quarter century has witnessed in British and American agriculture, and its most remarkable feature is the contrast which these two chapters present. The first begins with the observation that the period 1875–1900 was a "fateful" one for the "greatest British industry," and in the opening pages shows that floods and stock diseases characterised the first, and drought the last decade of this period; that for every 100 acres under wheat in 1875 there were but fifty-four in 1900; that wheat worth 45*s.* per quarter in the former year was worth 27*s.* in the latter, and that two Royal Commissions investigated the distressed condition of the British farmer. Passing from this melancholy narrative to the chapter on agriculture in the States, we find the American writer revelling in the resources of his country. Between 1875 and 1897 the States farmer took possession of as much new land as would cover all France and Germany.

> "Since 1870 the production of nearly all farm crops increased more rapidly than the population, the most absolute proof of the prosperity of the people."

As a result of better implements and better tillage, the yield of wheat is gradually increasing, and will, it is believed, continue to increase. Much land is yet available for wheat-growing, and the idea that a generation hence Americans will cease exporting wheat is regarded as quite erroneous.

The illustrations of British live stock are excellent, and the specimens the photos of which are given prove that "depression" has not yet succeeded in wresting from our breeders the preeminent position they held when the ninth edition was published. We are proud of our draught horses and we congratulate ourselves on their increase; but so different is the American standpoint that the writer almost apologises for their presence.

> "Until the use of more and cheaper motors becomes possible, farm animals must increase with farming operations."

It is significant in this connection that all the illustrations of animals are British and all the illustrations of machines American. Some of the implements shown are popular in this country, and some of them are largely manufactured here, but though the workmanship is British the ideas are exclusively American.

Agricultural education and research are actively carried on in the States; on research alone nearly 700 workers are engaged. The English writer describes the work done at Rothamsted, "the greatest and the oldest of experiment stations"; but Lawes and Gilbert are dead and there is no mention of progress. Are we standing still? The writer of the article "Agricultural Machinery" prefaces his chapter by remarking that Americans, as implement makers, have gone "far ahead" of their rivals in the United Kingdom, and "the following article is accordingly written from an American standpoint." The volume does not inspire much hope, but hope and work we must if the next edition of the "Encyclopædia Britannica" is to deal with agriculture from a *British* point of view.

Among the contributions on botanical subjects, the article on the "Algæ" is eminently satisfactory, not only as regards the array of facts, but also as incorporating the results of recent researches and the modifications in arrangement derived therefrom. The connection of the Cyanophyceæ with the Schizomycetes and the relationship of the Diatomaceæ to the Peridiniaceæ are pointed out. Evidence for and against alternation of generations is fairly weighed up, while on polymorphism the conservative view of Klebs is maintained. The physiological principles underlying "Anatomy" are clearly brought out in dealing with non-vascular plants. But when the writer elaborates the stelar conception in connection with vascular plants these principles fall into the background. A tolerably safe course is steered through stelar difficulties, but no attempt is made to separate purely topographical changes from those of a morphological nature. The "Angiosperms" are treated almost entirely from the physiological point of view. Autotrophic plants are described as geophytes, aërophytes and hydrophytes. The author's views on phylogenetic relationships would have been extremely interesting, but discretion overrules speculation. The systems of Bentham-Hooker and Engler-Prantl are merely outlined, while van Tieghem's novel classification is shortly criticised.

The article upon "Universal Algebra" gives in three pages a summary account of the various special algebras which have been invented by modern analysts. Such, for instance, are Hamilton's calculus of quaternions, Grassmann's extensive calculus, and the barycentric calculus of Möbius. The article on "Algebraic Forms" occupies thirty-seven pages, and is divided into sections dealing respectively with determinants and elimination, symmetric functions, binary and other forms, enumerative functions with their generators, and the theory of restricted substitutions. For the first time, perhaps, the methods of the English school have been discussed, in the same work, in conjunction with the symbolic calculus of Aronhold and Clebsch. Each method has its own special advantages, and the comparative study of both is very instructive. A good deal of space is devoted to Gordan's important theory of transvectants and their reduction, and to Stroh's recent extension of symbolic methods. Many parts of the article illustrate the value of the partition analysis as developed by MacMahon; what he calls "the theorem of expressibility," and the correspondence which he establishes between differential operation and partition operators, are real and fruitful contributions to mathematical science. This article is valuable, not only as a record of known facts, but also as suggesting new fields of research. The section on determinants contains little, if anything, that is not in the text-books; if this had been suppressed, and some other topics treated at greater length, it would have been an advantage.

"Astronomy" occupies twenty-eight pages, which contain a general account of some recent developments relating to the solar system, gravitational and theoretical astronomy, and the sidereal universe. In the section upon the planets, descriptions are given of progress in such subjects as the rotation periods of Mercury and Venus, the markings on Mars, the minor planet Eros, new satellites of Jupiter and Saturn, and Keeler's proof of the discrete constitution of Saturn's rings. The view that the dark regions on Mars are not oceans, as was formerly supposed, but the solid surface of the planet, is accepted, and also that which regards the canals or channels as not being physically continuous formations, but optical effects produced by more or less irregular differences in the minute shadings and colour tints on the surface of the planet.

In the section on gravitational and theoretical astronomy, the chief advances recorded relate to apparent deviations from the law of gravitation exemplified by motions of the planetary perihelia and inequalities of the moon's mean motion, and variation of latitude. The application of photography to celestial portraiture is briefly dealt with in the section on the fixed stars, and it is suggested that what is now required is a photographic survey of the heavens with the view of determining all the stars which have an appreciable parallax. Special attention is given to the structure of the sidereal universe and to systems of stars and clusters, but very little is said of spectroscopic advances in either connection. As progress in astronomy during the last quarter of a century means to a large extent progress in astrophysics, which depends almost entirely upon the spectroscope for its development, we assume that spectroscopic astronomy will be dealt with separately. The article certainly does not convey an accurate or adequate view of the physical and chemical aspects of the science, and it must be supplemented by one on celestial spectroscopy if the complete work is to be regarded as worthy of the intentions of the editors.

To everyone familiar with astronomical progress during the past quarter of a century, the article will be disappointing; for it is more of the nature of an essay than a contribution to an encyclopædia. What is required in an encyclopædic article upon any science is a concise and unbiassed summary of work and results, otherwise the contribution is misplaced. Measured by this standard, the article on astronomy fails entirely of its purpose, for it is both prolix and incomplete. Many small text-books contain far better statements of the position of astronomical science than is here given, because the authors have been to the trouble to become acquainted with the literature of the subject. This, however, has evidently not been done by the writer of the article under notice, and the result is a contribution which will give readers very imperfect ideas as to progress made since the contribution for the ninth edition was written. The new edition of the encyclopædia afforded an opportunity for giving a view of the vast amount of new material which has been accumulated by astronomers from unlooked-for sources, but instead of this inspiring survey we have a superficial essay upon a few points which have appealed to the writer. The article should have been a record of all essential advances of the science, whereas it is more remarkable for what is omitted than for what is included.

Few articles in the ninth edition of the encyclopædia could have required more extensive revision and addition than those devoted to zoological subjects. How great was the need for such revision, and how marked has been the progress in zoological discovery since the appearance of the former edition, is manifest by the articles in the volume under notice, which include the subjects "Amphibia," "Amphioxus," "Anatomy," "Anthropology," "Arachnida" and "Arthropoda." Some of these are in great part practically new treatises, while others, such as the one on anthropology, confine themselves to the additions necessary to bring their predecessors up to date. The change of view that has taken place with regard to the relationships of the lower vertebrates will be manifest when the new and the old articles on amphibia are contrasted, while the advance in our knowledge of the structure of the extinct representatives of the latter is apparent by the amount of space allotted to this portion of the subject. The article on Amphioxus is entirely new, and occupies nearly four pages.

The discoveries of modern histological methods of investigation are fully recorded under the heading of "Anatomy," while the Pithecanthropus is alluded to under "Anthropology," and Mr. Henry's method of classifying finger-prints receives mention in the article "Anthropometry." The Funafuti boring and the inferences to be drawn therefrom are discussed in some detail under "Anthozoa"; while in "Arachnida," Prof. Ray Lankester adduces a long string of facts to show that the nearest living relatives of kingcrabs and trilobites are scorpions rather than crustaceans. Several of the authors had by no means an easy task before them in bringing up to date the work of their predecessors, but they all seem to have done their parts in a highly satisfactory manner.

Finally, we may say that an earnest endeavour has been made by the editors to produce a work which represents the advances of science since the ninth edition was prepared, in so far as they come within the purview of the present volume. Whether considered as one volume of a supplement to the ninth edition or as a statement of the position of many scientific subjects, the work is a worthy addition to our national literature.

PRACTICAL PHYSIOLOGY.

Directions for Class Work in Practical Physiology. Elementary Physiology of Muscle and Nerve and of the Vascular and Nervous Systems. By E. A. Schäfer, LL.D., F.R.S. Pp. 76. (London: Longmans, Green and Co., 1901.) Price 3*s.* net.

THE contents of this book are well-nigh sufficiently indicated by its subsidiary title, and it is inconceivable that in dealing with the elementary aspects of the subjects named its distinguished author could go wrong. He informs us that his directions are based upon an experience of many years in University College, London, and that they deal "only with such elementary exercises as can readily be worked out by even a large class."

There are twelve chapters in all, and the most distinctive feature of the book is the manner in which the student, having been given concise instructions as to the nature and mode of utilisation of apparatus, and of preparation of the organic object to be studied, is left to "notice" or observe for himself the nature of the effect of this or that operation. A most wholesome procedure—a method of the kind which must be always begotten of a lengthy teaching experience such as the author proclaims.

Of the twelve chapters, the first opens with a description of the "voltaic element" and of the Daniell cell, the rationale of the replacement of the former by the latter being clearly explained. The Grove and Leclanché cells, with the chief types of the latter, are in turn considered; and, with adequate descriptions of electrodes, keys, rheochords, the induction coil and their uses, and a section on unipolar induction, the chapter closes. Chapters ii. and iii. are devoted to nerve-muscle preparations, the sartorius being utilised for the demonstration of the independent irritability of muscle and nerve, and the hyoglossus for that of the "latent period." The effects of heat and cold, of fatigue, the action of curari and veratrin, are in due course considered and clearly set forth; and in chapters v., vi. and vii. the effects of successive stimulation, leading up to tetanus and the muscle sound, the rate of the nervous impulse, the effects of CO_2 and the "electrotonus" phenomenon, are simply described, Ritter's and Pfluger's laws being incidentally laid down.

Chapter viii. deals with secondary contraction and the use of the capillary electrometer and galvanometer. The two chapters which follow are devoted to the heart, cardiac nerves, and the use of the plethysmograph; and the two which conclude the work deal with the chief vascular and respiratory mechanisms in man, with reflex action and its time limitations, as determinable by the use of the Wallerian lever apparatus.

There are in all forty-five simple text-illustrations, thirty-eight of apparatus and seven of dissections of the common frog. The book is well worthy its aim, and Prof. Schäfer, clearly of a mind to give the elementary student little and good, has done that functionary a great service.

There are, in addition to the seventy-six printed pages, twenty-six which are blank; but whether, according to the bookbinder's custom, these are intended to give stability to an otherwise thin volume, or whether they are for the convenience of the student in making annotations, we are not informed. As matters now progress, however, in electrophysiology, it would seem that ere long one or two of these blank pages may be destined to bear a thirteenth chapter, since the Eastern mind, coming fresh and untrammelled to the work, is showing us that under a mechanical stimulus phenomena of electrical response akin to those until recently demonstrated only for the higher animals and the sensitive plants, appear to be at least also obtainable from vegetable organisms at large—a result which points to the conclusion that in these well-known phenomena we are dealing with a fundamental property of protoplasm, and calls for immediate investigation of the unicellular organisms, in the study of which the clue to all that is physiological has ever to be sought.

OUR BOOK SHELF.

The Elements of Physical Chemistry. By J. Livingston R. Morgan, Ph.D. Second edition. Pp. x + 352. (New York: Wiley and Son; London: Chapman and Hall, Ltd., 1902.) Price 2 dollars.

TO write a book the object of which is to present the elements of the entire subject of physical chemistry, together with the important and but little known applications of it to the other branches of chemistry, within the scope of 322 small pages is by no means an easy task. The author has, however, succeeded in presenting within these limits a very readable account of the subject.

To the reader familiar with the works on physical chemistry and electrochemistry published by German authors during the last ten years, a close likeness between these and the present volume is at once apparent. The author, as a matter of fact, in his preface states that no claims of originality are made for the major portion of the text.

It is doubtful whether a text-book which is obviously intended for the use of comparatively elementary chemical students should be so replete with mathematical formulæ. For a beginner, a more descriptive method of treatment of the subject would have been, in the opinion of the reviewer, more satisfactory.

The subject-matter is divided into ten chapters, the first being devoted to introductory remarks on the subject of energy and methods of determining atomic weights; then follow sections on the gaseous, liquid and solid states, solution, thermochemistry, chemical change, phases and electrochemistry, the last chapter containing a series of 156 problems bearing upon the subject-matter of the text. This last chapter is a most welcome innovation. For the beginner, the very numerous and abstract formulæ of physical chemistry have but a vague significance; only when these formulæ have been applied to concrete cases do they become properly understood by the student. Ample scope for exercise in the application of these formulæ is provided by the last chapter, although perhaps in a few cases the problems are not very happily chosen.

Thermochemistry and the phase rule are treated of in a superficial manner, only five pages being devoted to the consideration of the latter. In a future edition it is hoped that the author will see fit to deal with the important work which has been done on transition tem-